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An Efficent Dynamic AODV Routing Protocol for Wireless Sensor Networks

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Abstract: ***An ad hoc network is a collection of wireless mobile hosts forming a temporary network without requirement of any existing infrastructure. In such an environment, to forward a packet from host to destination require a mobile host. This paper presents a protocol for routing in Mobile ad–hoc networks .Dynamic Source Routing which is a reactive routing protocol adapts quickly to routing changes when host movement is frequent, yet requires little or no overhead during periods in which hosts move less frequently. The DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network without the need for any existing network infrastructure or administration. The protocol is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the ad hoc network. Source routing allows packet routing to be trivially loop-free, avoids the need for up-to-date routing information in the intermediate nodes through which packets are forwarded, and allows nodes forwarding or overhearing packets to cache the routing information in them for their own future use. DSR is entirely on-demand.***

Keywords: MAC, MANET, DSR, AODV

I. INTRODUCTION

A computer network is an interconnected collection of autonomous computers. Recently, there has been tremendous growth in the sales of laptop and mobile computers. Moreover, many of these small computers operate for hours with battery power, users are free to move about at their convenience with out being constrained by wires. If you have a mobile device it make sense only if you are exchanging the information with other nodes. Mobile hosts such as notebook computers, featuring powerful CPUs, large main memories, hundreds of megabytes of disk space, multimedia sound capabilities, and color displays, are now easily affordable and are becoming quite common in every business and personal life At the same time, network connectivity options for use with mobile hosts have increased dramatically, including support for a growing number of wireless networking products based on radio and infrared. With this type of mobile computing equipment, there is a natural desire and ability to share information between mobile users. Often, mobile users will meet under circumstances that are not explicitly planned for and in which no connection to a standard wide area network such as internet is available. Impractical due to the time or expense required for connection these kinds of networks of mobile hosts have been known as Ad – hoc Networks. A mobile Ad - hoc Network is a network that results from the co–operative engagement of a collection of hosts without any centralized access point. Routing protocols in MANETS are not performed by routers, but performed by normal hosts. The network topology will also change dynamically as the hosts “move” around with in the network and so the routing protocol must be flexible enough to ensure that data gets routed correctly and efficiently. Most of the protocols exhibit their least desirable behavior in a highly dynamic topology. This has resulted in the need for new routing protocols in MANETS. In many Ad–hoc Networks, those two hosts that want to communicate may not be with in the wireless transmission range of each other, but could communicate if other hosts between them also

participating in the Ad – hoc Network are willing to forward packets for them.

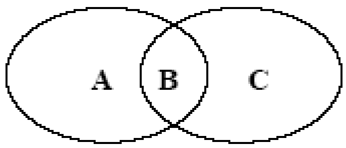


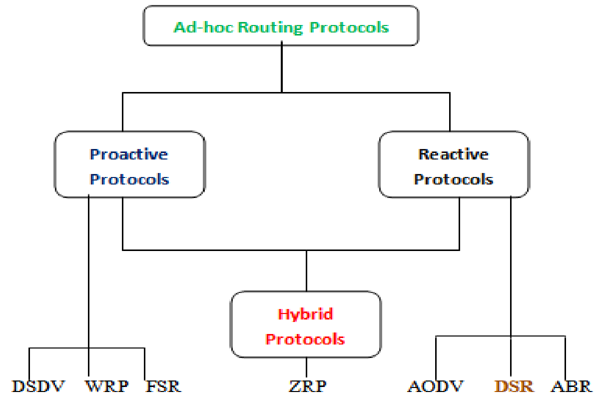
Fig 1: Example Ad Hoc Network

For Example in Fig 1 mobile host C is not with in the range of host A's wireless transmitter. And host A is not with in the range of host C's wireless transmitter. If A and C wish to exchange packets, they may in this case enlist the services of host B to forward packets for them, since B is with in the overlap between A's range and C's range.

This paper is organized as follow: Section I gives the Introduction of the Routing Efficient Opportunistic. Section II is helpful to understand the background of related work. Section III explains basic operations of DSR. Section IV discusses route mechanism in detail and the last section V concludes the paper and followed by the references.

II. CATEGORIES OF AD-HOC ROUTING PROTOCOLS

Currently, the wireless networks that allow communication between mobile devices can be classified into the following two categories:
1. Networks having a fixed infrastructure: an example of such a network is a cellular phone network.
2. Networks that do not have a fixed infrastructure: this is an emerging but highly useful and promising type of network communication method. There are several situations where such a network would be indispensable; mostly, in unplanned events like natural disasters and wars, but also in a planned event. This type of network can be described as a network of mobile devices that is created or destroyed as needed and hence it is named a mobile ad hoc network or MANET. In wireless networks, physical links do not exist and a single transmission of a packet will transfer a packet to multiple nodes within the communication range of a transmitting node at the same time. We call this inherent broadcast of MANETS 'local broadcast'



DSDV : Destination Sequence Distance Vector
WRP : Wireless Routing Protocol
FSR : Fisheye State Routing

ZRP : Zone Routing Protocol

ADOV : Ad hoc On Demand Distance Vector
DSR : Dynamic Source Routing
ABR : Associativity Based Routing

Fig 2. Categorization of ad hoc routing protocols

Several routing protocols have been proposed for mobile ad hoc networks. These can be categorized as proactive (also known as table-driven) protocols, reactive (known as source-initiated or demand-driven) protocols or the hybrid of the reactive and proactive protocols. A categorization of the prominent ad hoc routing protocols is shown in Fig2

Routing protocols in conventional wired networks generally use either distance vector or link state routing algorithms, both of which require periodic routing advertisements to be broadcast by each router. In distance vector routing, each router broadcasts to each of its neighbor routers its view of the distance to all hosts, and each router computes the shortest path to each host based on the information advertised by each of its neighbors. In link state routing, each router instead broadcasts to all other routers in the network its view of the status of each of its adjacent network links, and each router then computes the shortest distance to each host based on the complete picture of the network formed from the most recent link information from all routers. In addition to its use in wired networks, the basic distance vector algorithm has also been adapted for routing in wireless ad hoc networks, essentially treating each mobile host as a router.

III. ASSUMPTIONS

All hosts in the ad hoc network should forward packets for other hosts in the network.

Diameter of the network is considered to be the number of hops necessary for a packet to reach from host located at one extreme edge of the network to host located at the opposite extreme.

The speed of the node mobility is considered to be moderate with respect to the packet. In particular, DSR can support very rapid rates of arbitrary node mobility, but here assumption is that hosts do not continuously move so rapidly as to make the flooding of every packet the only possible routing protocol.

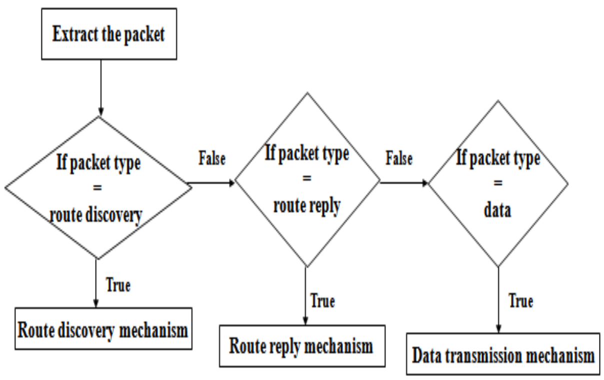


Fig 3: Basic operation- Flow chart of Dynamic Source routing protocol

Mobile users will want to communicate in situations in which no fixed wired infrastructure is available, either because it may not be economically practical or physically possible to provide the necessary infrastructure. If only two hosts, located closely together, are involved in the ad hoc network, no real routing protocol or routing decisions are necessary. In many ad hoc networks, though, two hosts that want to communicate may not be within wireless transmission range of each other, but could communicate if other hosts between them also participating in the ad hoc network are willing to forward packets for them.

IV. DSR PROTOCOL DESCRIPTION

The Dynamic Source Routing Protocol is a source-routed on-demand routing protocol. A node maintains route caches containing the source routes that it is aware of. The node updates entries in the route cache as and when it learns about new routes. The two major phases of the protocol: Route Discovery and Route Maintenance. When the source node wants to send a packet to a destination, it looks up its route cache to determine if it already contains a route to the destination. If it finds that an unexpired route to the destination exists, then it uses this route to send the packet. But if the node does not have such a route, then it initiates the route discovery process by broadcasting a route request packet. Each intermediate node checks whether it knows of a route to the destination. If it does not, it appends its address to the route record of the packet and forwards the packet to its neighbors. A route reply is generated when either the destination or an intermediate node with current information about the destination receives the route request packet. A route request packet reaching such a node already contains, in its route record, the sequence of hops taken from the source to this node. DSR uses two types of packets for route maintenance: Route Error packet and Acknowledgements. When a node encounters a fatal transmission problem at its data link layer, it generates a Route Error packet. When a node receives a route error packet, it removes the hop in error from it's route cache. All routes that contain the hop in error are truncated at that point. Acknowledgment packets are used to verify the correct operation of the route links. This also includes passive acknowledgments in which a node hears the next hop forwarding the packet along the route.

The basic operation of Dynamic Source Routing protocol consists of two operations. They are Route Discovery And Route Maintenance.

So after extracting the packet we have to check the packet type in order to perform a particular operation shown in Fig(3).

To send a packet to the another host, the sender constructs a source route in the packets header, giving the address of each host in the network through which the packet should be forwarded in order to reach the destination host. The sender then transmits the packet over its wireless network interface to the first hop identified in the source route. When a host receives a packet, if this host is not the final destination of the packet, it simply transmits the packet to the next hop identified in the source route in the packets header. Once the packet reaches its final destination, the packet is delivered to the network layer software on the host.

Each mobile host participating in the Ad – hoc Network maintains route cache in which it catches

source routes that it has learned, when one hosts sends a packet to another host, the sender first checks its route cache of a source to the destination if a route is found, the sender uses this route to

transmit the packet. If no route is found, the sender may attempt to discover one using the route discovery protocol. While waiting for the route discovery to complete, the host may continue normal processing and may send and receive packets with other hosts.

If the sender, the destination or any of the other hosts named as hops along a route move out of wireless transmission range of next or previous hop along the route, the route can no longer be used to reach the destination. A route will also no longer work if any of the hosts along the route should fail or be powered off. This monitoring of the correct operation of a route in use we call route maintenance. When route maintenance detects a problem with route in use, route discovery may be used again to discover a new correct route to the destination.

If a node wants to send any information to the remaining nodes it sends the information by placing it in the form of packet.

The problem of routing can be divided into the two areas of route discovery and route maintenance, in order for one host to communicate with another, it must initially discover a suitable route to use in sending packets to that destination. As long as conditions remain unchanged, this route should then continue to work for as long as It is needed. However, as the status of different links or routers used in this route change, changes in the route may be necessary, or a new route may needed to be discovered.

A. ROUTE DISCOVERY

In an Ad hoc Network, if the source and target mobile hosts are both within transmission range of each, other, a simple query is all that is needed to find a “route” to the target host. The returned MAC address may be used directly to transmit packets to that host. In this case no periodic routing updates are needed, providing substantial savings in network bandwidth and battery power requirement for all involved. A general solution to route discovery in Ad hoc Networks is a technique for extending this to the case in which source and but to propagate the request using some form of flooding, in order to reach other mobile hosts

beyond the senders transmission range. As the request propagates, each host adds its own address to route being recorded in the packet, before broadcasting the request on to its neighbors. When receiving a request, if host finds its own address already recorded in the route, however, it discards the copy of the request and does not propagate that copy further. Since many mobile hosts may be with in transmission range of each other, though there may be many duplicate copies of each request propagated. To largely eliminate these duplicates, each request should contain a unique request id from the original sender. Each host keeps a cache giving the request id and sender address of recently forward requests, and discards a request rather than propagating it if it has already propagated an earlier copy of the same request id. Thus each host will only propagate the first copy of each request that it receives. This will usually be the copy that came to it along the shortest path from the original sender, and this is most useful in finding the shortest path to the final target. This scheme could easily be extended, though, to include the length of the path in the request id cache and to propagate a later copy of the same request if it some how arrived over a shorter path than early copy.

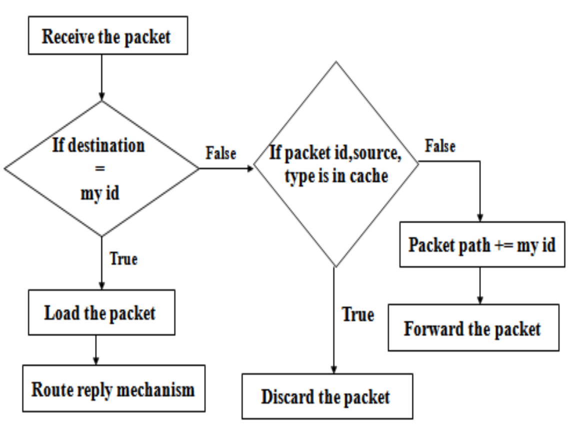
Limiting the maximum number of hops over which any route discovery packet can be propagated, can thus further reduce the number of duplicate requests propagated. When processing a received route discovery request rather than forwarding it if it is not the target of the request and if the route recorded in the packet has already reached the maximum length. When the query packet ultimately reaches the target host, the complete route from the original sender to this host will have been recorded in the packet. In order to be use to the original sender, the target host may attempt to reverse the recorded route to reach to the original sender, or may use the same route discovery procedure to find a route back to the original sender. The route from the original sender to this target should be returned to the sender in new query packet used for its own route discovery; this route discovery exchange between the two end mobile hosts could optimally be piggybacked on the first data packets sent between them.

Mobile hosts should cache routes for use in sending future packets to that same destination, making more extensive use of such caching can

further reduce the overhead of the protocol. If a mobile host has cached a route listing some number of hops to a destination mobile host, then the shortest route to each of the hops listed on that route is naturally a prefix of that route. In this case, no new route discovery is needed for this mobile host to communicate with any of the other mobile hosts named as hops on any of the routes currently in its cache. Also, as a mobile host forwards

packets, it will be able to observe many other routes to mobile hosts, since each packet contains a route. By examining the routes on packets that it

forwards, a mobile host may be able to cache routes to new destinations or to obtain updated information to destinations already in its cache. Further more, since transmissions in a wireless network are Necessarily broadcast transmissions, a mobile host may be able to learn new routing information from the route contained in any packet that it can receive, even if the packet not explicitly addressed to this host Route discovery allows any host in the Ad-hoc Network to dynamically discover a route to any other host in the Ad-hoc Network. A host initiating a route discovery broadcasts a route request packet which may be received by those hosts with in wireless transmission range of it. The route request packet identifies the host, referred to as the target of the route discovery for which the route is requested. If the route discovery is successful the initiating host receives a route reply packet listing a sequence of network hops through which it may reach the target.



In addition to the address of the original initiator of the request and target of the request, each route request packet contains a route record, in which is accumulated a record of sequence of hops taken by the route request packet as it is propagated through the Ad – hoc Network during route discovery. Each route request packet also contains a unique request id, set by the initiator from the locally maintained sequence number. In order to detect the duplicate route requests received each host in Ad - hoc Network maintains a list of the "initiator address, request id" pairs that it has recently received on any route request. When host receives the route request packet it processes the request according to the following steps:

- If the pair "initiator address, request id" for this route request is found in the hosts list of recently seen requests, then discard the route request packet and do not process it further.
- Otherwise, if this host address is already listed in the route record in the request then discard the route request packet and does not process it further.
- Other wise if target of the request matches machines own address, then the route record in the packet contains the route by which the request reached this host from the initiator of the route request return a copy of this route in a route reply packet to the initiator.
- Otherwise append this hosts own address to the route record in the route request packet, and rebroadcast the request. The route request thus propagates Ad – hoc

Network run until it reaches the target host, which then replies to the initiator. The original route request packet is received by those hosts within the wireless transmission range of initiating host, and each of these hosts propagates the request if it is not the target and if the request does not appear to this host to be redundant. Discarding the request because the hosts address is already listed in the route record guarantees that no single copy of the request can propagate around the loop. Also discarding the request when the host has recently seen one with the same "initiator address, request id" removes later copies of the request that arrive at this host by a different route.

B. ROUTE REPLY MECHANISM

In order to return route reply packet to the initiator of the route discovery the target host must have a route to the initiator. If the target has an entry for this destination in its route cache, then it

may send the route reply packet using this route in the same way as is used in sending any other packet which is shown in Fig (5)

Otherwise the target may reverse the route record from the route request packet, and use this route to send the route reply packet. This however, requires the wireless network communication between each of these pairs of hosts to work equally well in both directions, which may not be true in some environments or with some MAC level protocols.

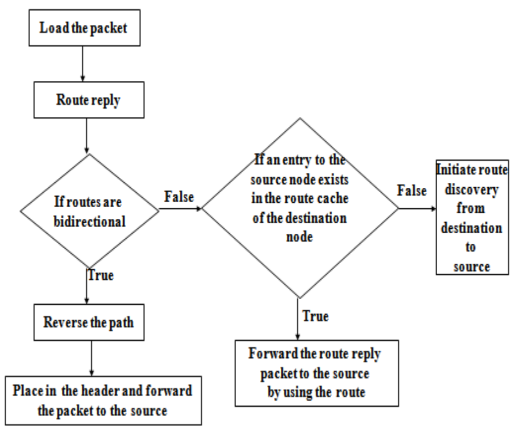


Fig 5: Route reply mechanism

C. ROUTE MAINTENANCE

Conventional routing protocols integrate route discovery with route maintenance by continuously sending the normal periodic routing updates. If status of a link or router changes, the periodic updates will eventually reflect the changes to all other routers, presumably resulting in the computation of new routes. With the separate route discovery approach a link or route going down would instead cause the route to mysteriously stop working with no feed back to the sender. The role of the route maintenance protocol is to provide this feedback, and to allow the route to be modified or a new route to be discovered in this case. In an Ad hoc Network, a route may also stop working if one or more of the mobile host along the route simply moves.

In many wireless networks, route maintenance can be provided with very little overhead. Since wireless networks are inherently less reliable than the wired networks. Many wireless networks utilize quite simple, since at each hop, the sender can determine if that hop of the route is still working. If the data link level reports a transmission problem for which it can not recover, all that is needed is to report this error back to the original sender to cause the host re-invoke the route discovery procedure to find a new route. It may also be possible for the intermediate host experiencing the error to instead use the route discovery procedure itself to extend the existing route on the correct packet.

If the wireless network does not support such lower level acknowledgements, an equivalent acknowledgement signal may be available in many

environments. After sending a packet to the next hop mobile host, the sender may be able to hear that host transmitting the packet again, on its way further along the path. As a last resort, a bit in the packet header could be included to allow a host transmitting a packet to request an explicit acknowledgement from the next hop receiver. If no other acknowledgement signal has been received in some time from the next hop on some route. The host could use this bit to inexpensively probe the status of this hop on the route.

While route is in use, the route maintenance procedure monitors the operation of the route and informs the sender of any routing errors. Many wireless networks utilize hop by hop acknowledgement at the data link level in order to provide early detection and retransmission of lost or corrupted packets. In these networks, route maintenance can be easily provided, since at each hop the host transmitting the packet for that hop can determine if that hop of the route is still working. If the data link level reports a transmission problem for which it can not recover, this hosts sends a route error packet to the original sender of the packet encountering the error. The route error packet contains the address of the hosts at both ends of the hop in error. The host that detected the error and the host to which it was attempting to transmit the packet on this hop. When a route error packet is received, the hop in error is removed from this hosts route cache, and all routes which contain this hop must be truncated at this point.

If the wireless network does not support such low level acknowledgements, an equivalent acknowledgement signal may be available in many environments. A bit in the packet header could be included to allow a host transmitting a packet to request an explicit acknowledgement from the next

hop receiver. If no other acknowledgement signal has been received in some time from the next hop on some route. The host could use this bit to inexpensively probe the status of this hop on the route.

As with the return of the route reply packet, a host must have a route to the sender of the original packet in order to return a route error packet to it. If this host has an entry for the original sender in its route cache it may send the route error packet using the route. Otherwise the host may reverse the route from the packet in error or may use piggybacking

as in the case of a route reply packet. Another option in the case of returning a route error packet is for this host to save the route error packet locally in the buffer, perform a route discovery for the original sender, and then send the route error packet locally in a buffer, perform a route discovery for the original sender, and then send the route error packet using that route when it receives the route reply for this route discovery.

Route maintenance can also be performed using end to end acknowledgements rather than the hop by hop acknowledgements. If the particular wireless network interfaces or the environment in which they are used are such that wireless transmissions between two hosts do not work equally well in both directions. With hop by hop acknowledgements, the particular hop in error is indicated in the route error packet, but with end to end acknowledgement, the sender may only assume that the last hop of the route to this destination is in error.

D. ROUTE CACHE

A host may use its route cache to avoid propagating a route request packet received from another host.

Suppose a host receives a route request packet for which it is not the target, and is not already listed in the route record of the packet, and for which the pair "initiator address, request id "is not found in its list of recently seen requests. If the host has a route cache entry for the target of the request, it may append this cache route to the accumulated route record in the packet, and may return this route in a route reply packet to the initiator without propagating the route request.

Before replying from its route cache a host performs the following actions.

1. Picks a delay period.

2. If packet is received by this host during the delay period addressed to the target of this route discovery, and If the length of the route on this packet is less than (delay period), then cancel the delay and do not transmit the route reply from this host, this host may infer that the initiator of this route discovery has already received a route reply, giving an equal or better route.

As last optimization involving full use of the route cache, we have added the ability for the initiator of a route request to specify in the request packet, the maximum no of hops over which the packet may be propagated. If another host near the initiator has a cache entry for the target of the route request, the propagation of many redundant copies of the route request can be avoided if the initiator can explicitly limit the request propagation when it is originally sent. Currently, we use this ability during route discovery as follows.

1. To perform a route discovery, initially send the route request with a hop limit of one. We refer this as a non propagating route request.
2. If no route reply is received from this route request after a small time period, send a new route request with the hop limit set to a predefined maximum value for which it is assumed that all useful routes in the Ad hoc Network are less than this limit.

IV. CONCLUSION

The Dynamic Source Routing protocol (DSR) provides excellent performance for routing in multi-hop wireless ad hoc networks. In this Paper, I have described the principle mechanisms of Route Discovery and Route Maintenance used by DSR, and has shown how they enable wireless mobile nodes to automatically form a completely self-organizing and self-configuring network among themselves. Further improvements to the performance of DSR, for example to allow scaling to very large networks, and the addition of new features to the protocol, such as multicast routing. My goal is to create an integrated set of protocols that allow mobile computers, and the applications running on them and communicating with them.

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